
JH 4880 F
#114
Venture Across America
WEST VIRGINIA
UNFORESEEN SECRETS OF DEEP SPACE REVEALED IN THE MONONGAHELA FOREST
N = R • Fp • Ne • Fl • Fi • Fc • L
Drake Equation
DID YOU KNOW...
The Green Bank telescope captures astronomical mysteries with cosmic radio waves. If there is life out there, will it be revealed - or has it been already?
LEARN MORE ABOUT SEARCH FOR ALIEN LIFE AT...
uhaul.com
U-HAUL
Mom's Attic
RIGHT EQUIPMENT / LOWEST COST
Where Will U Go Next?
MOVING MADE EASIER
Gentle-Ride Van

Project Ozma - 1960
Green Bank: Tatel Telescope
1 channel, 2 stars

The 85-foot steerable antenna at the National Radio Astronomy Observatory, Green Bank, W. Va., was focused last year for a total of 150 hours on Tau Ceti and Epsilon Eridani, the two nearest solartype stars, during the initial phase of the "Ozma" experimental program. No evidence of intelligent transmissions was found (nor had any really been expected), but the experiment provided means for testing the telescope's radiometer installation shown in the second photograph. In left foreground is the data digitizer and the console at right is the antenna control. The Project Ozma receiver can be seen at left rear. Equipment in center background is the 21-cm receiver.

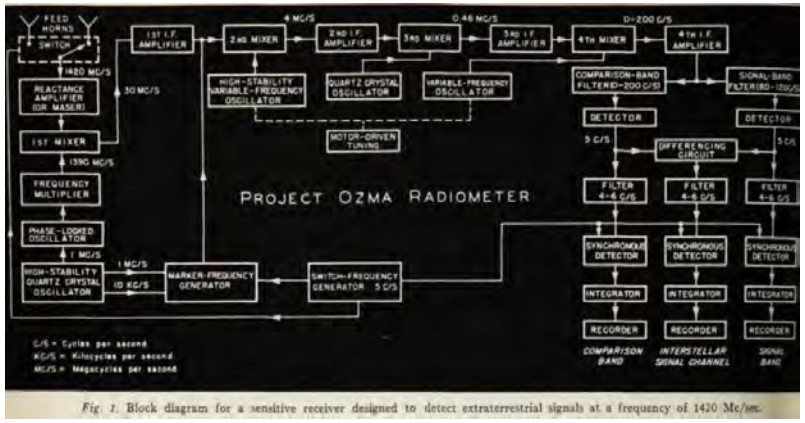
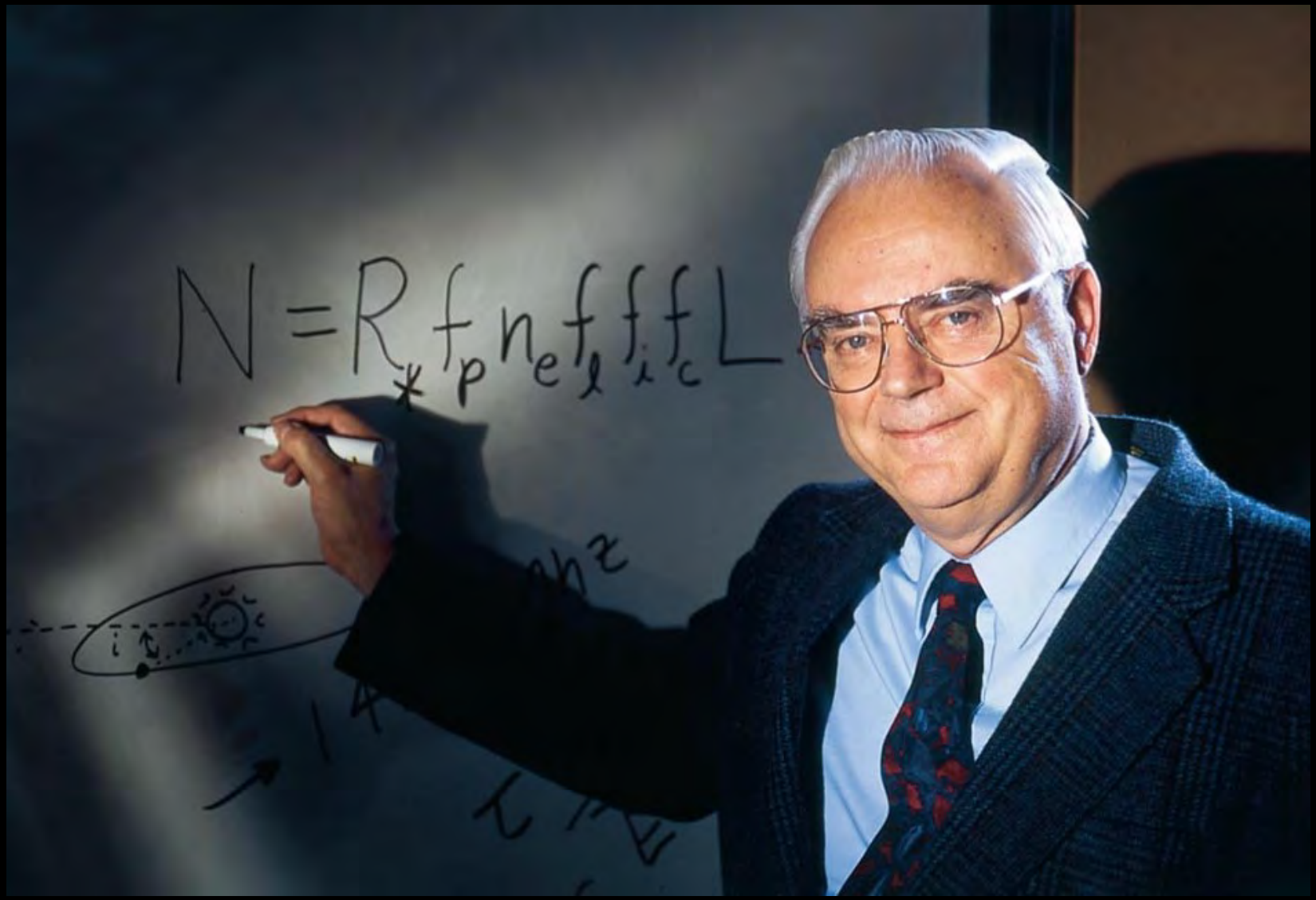


Fig. 1. Block diagram for a sensitive receiver designed to detect extraterrestrial signals at a frequency of 1420 Mc/sec.

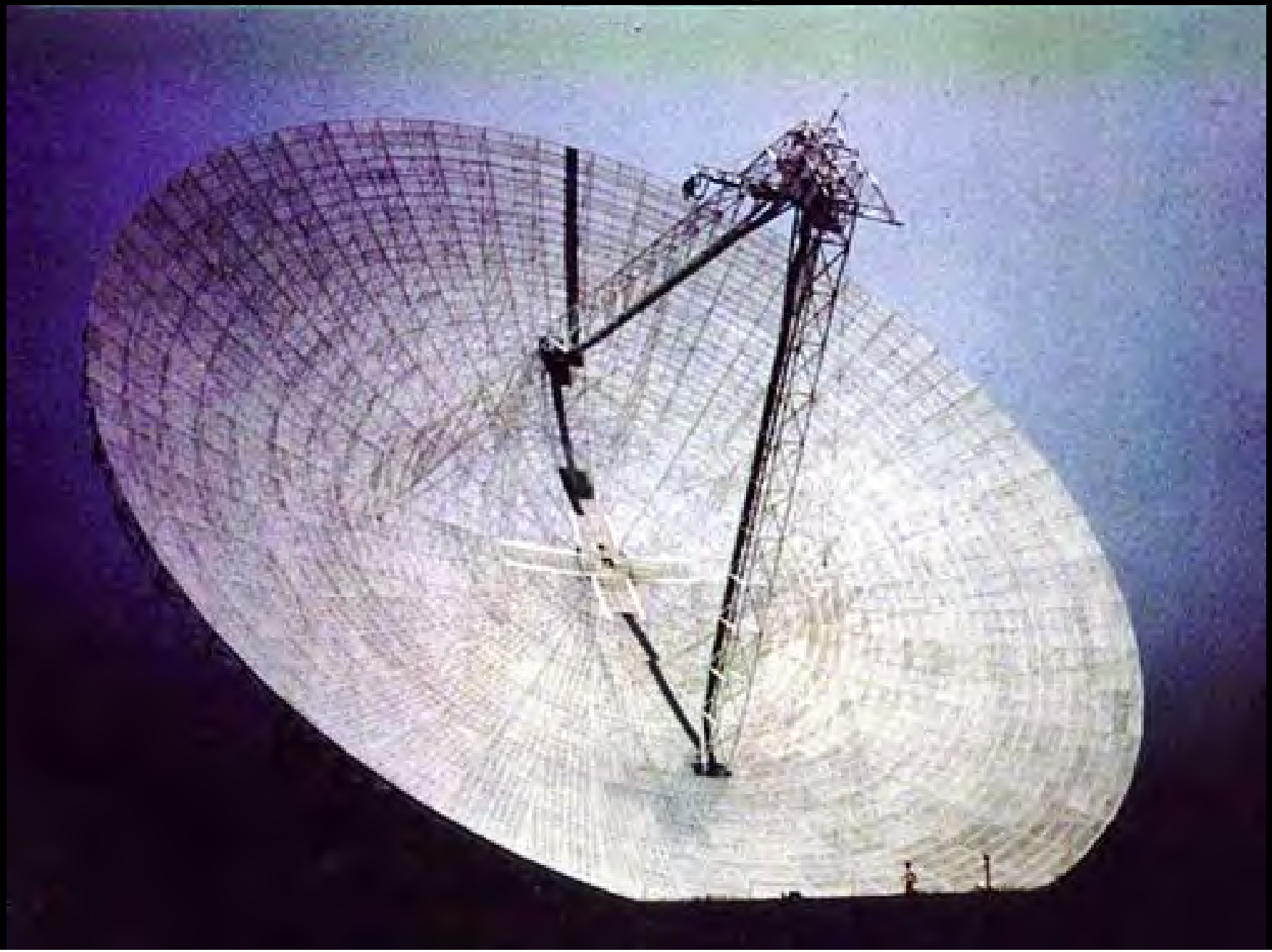
Drake, F. (1961). "Project Ozma." *Physics Today, 14*(4), 40.

Green Bank SETI Conference – 1961



Drake Equation – 1961 – Way to Organize a Conference

300 Foot Telescope - 1962

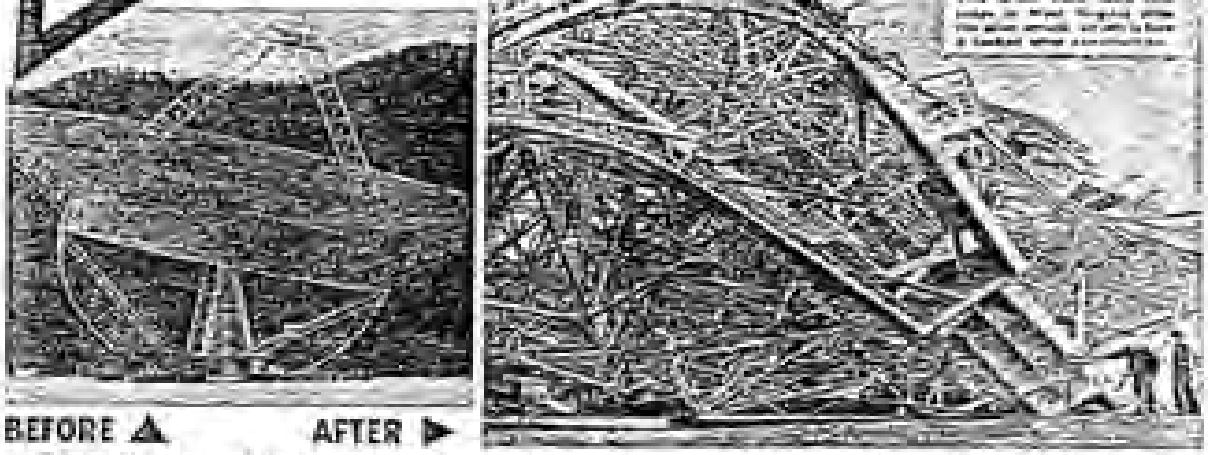


Green Bank Commensal Sky Survey
SERENDIP II, 65K channels, 1985 -1988

America's most powerful radio telescope IS . . .

ZAPPED!

. . . by hostile space aliens!



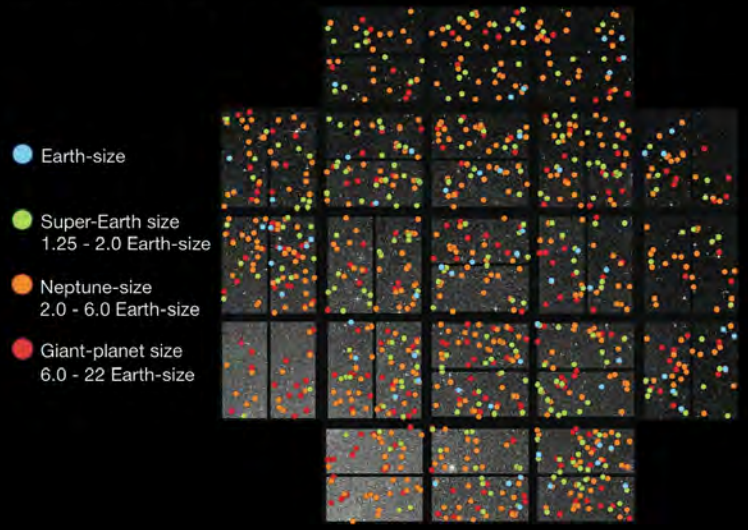
BEFORE ▲ AFTER ▶

Brave dog


The Robert C. Byrd
Green Bank
Telescope

Serendip VI SETI & GreenBurst FRB

Commensal - Dedicated L Band Spigot - Ron Maddalena



Kepler Planet Search
Andrew Siemion

GBT Targeted Searches
Jean-Luc Margot
and his students
UCLA SETI Course

The Breakthrough Listen Initiative: Telescopes

Automated Planet Finder (Lick Observatory)

- Search for extremely narrow emission lines from artificial lasers
- Extremely high resolution "Levy Spectrometer" 374 - 950 nm, $\lambda/\Delta\lambda = 10^5$

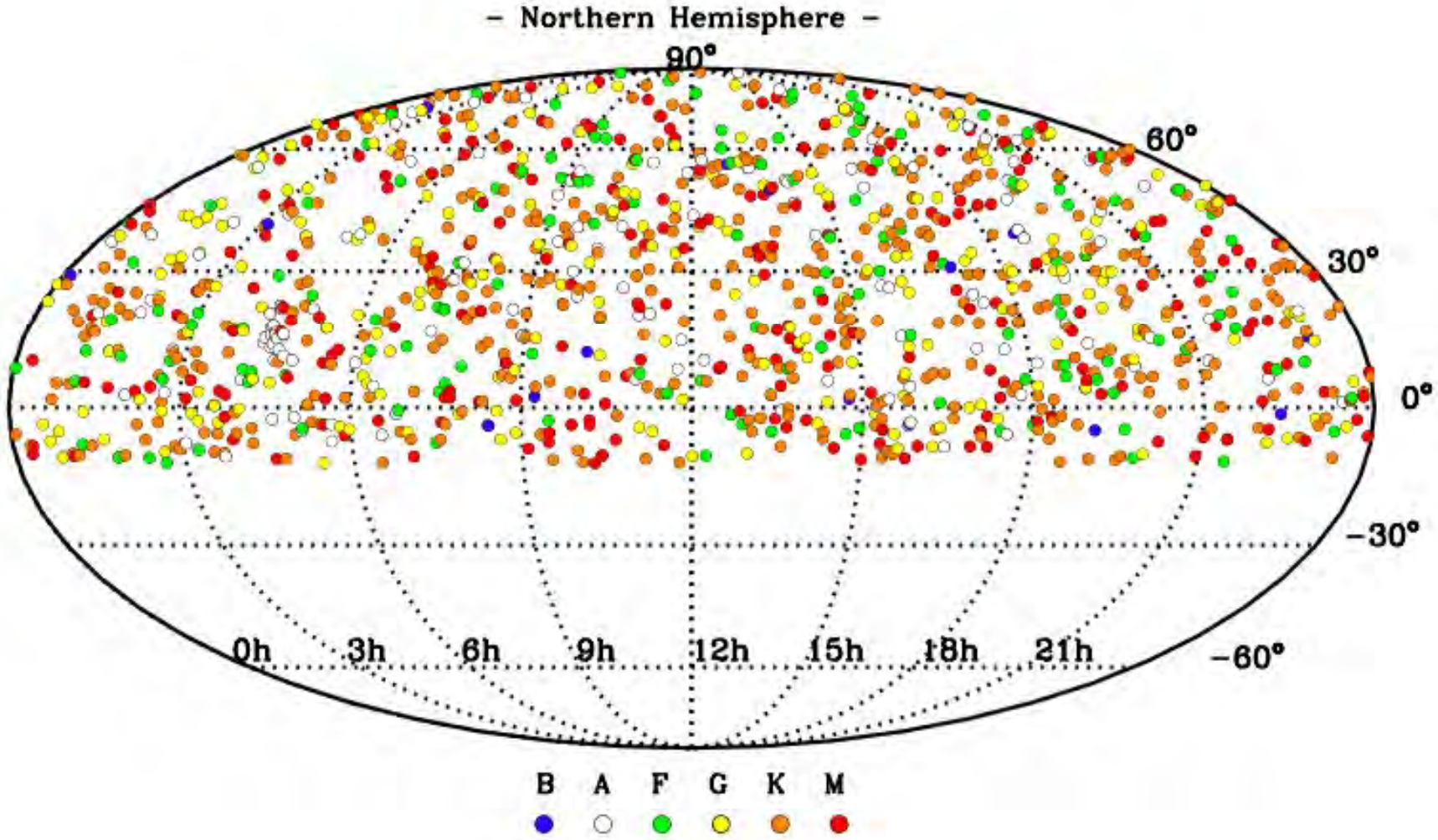
Green Bank Telescope (Green Bank, WV)

- Radio search focusing on targeted and raster observations
- Nearly continuous frequency coverage 300 MHz - 100 GHz
- Flexible IF system can deliver up to 10 GHz dual-pol analog bandwidth

Parkes Telescope (New South Wales, Australia)

- Radio search focusing on surveys
- Southern hemisphere location gives great access to galactic plane
- Multi-beam receiver allows very efficient L-band (1.2 - 1.5 GHz) sky surveys

1220 Nearby Target Stars
for
Breakthrough *LISTEN* & NIROSETI

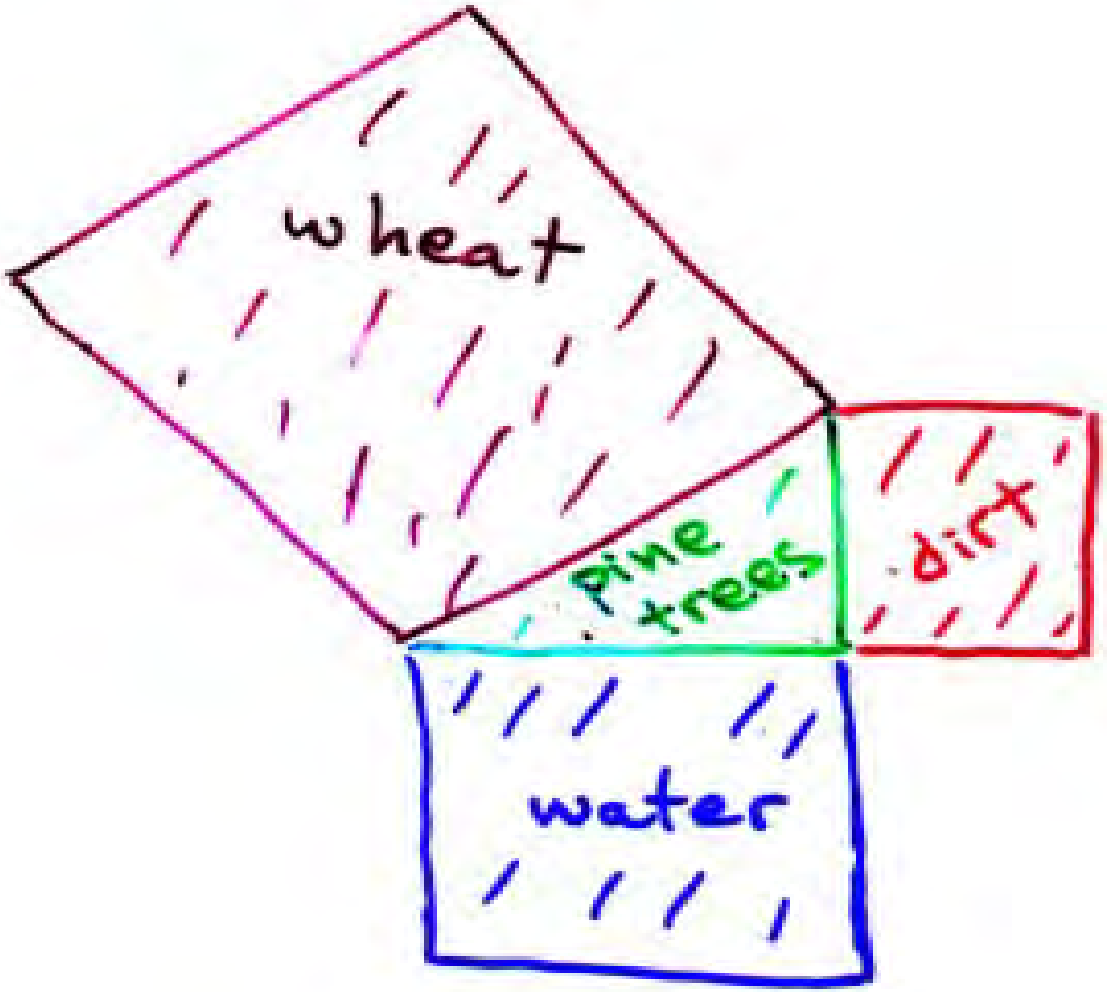


First the bad news:
We don't know what we are doing

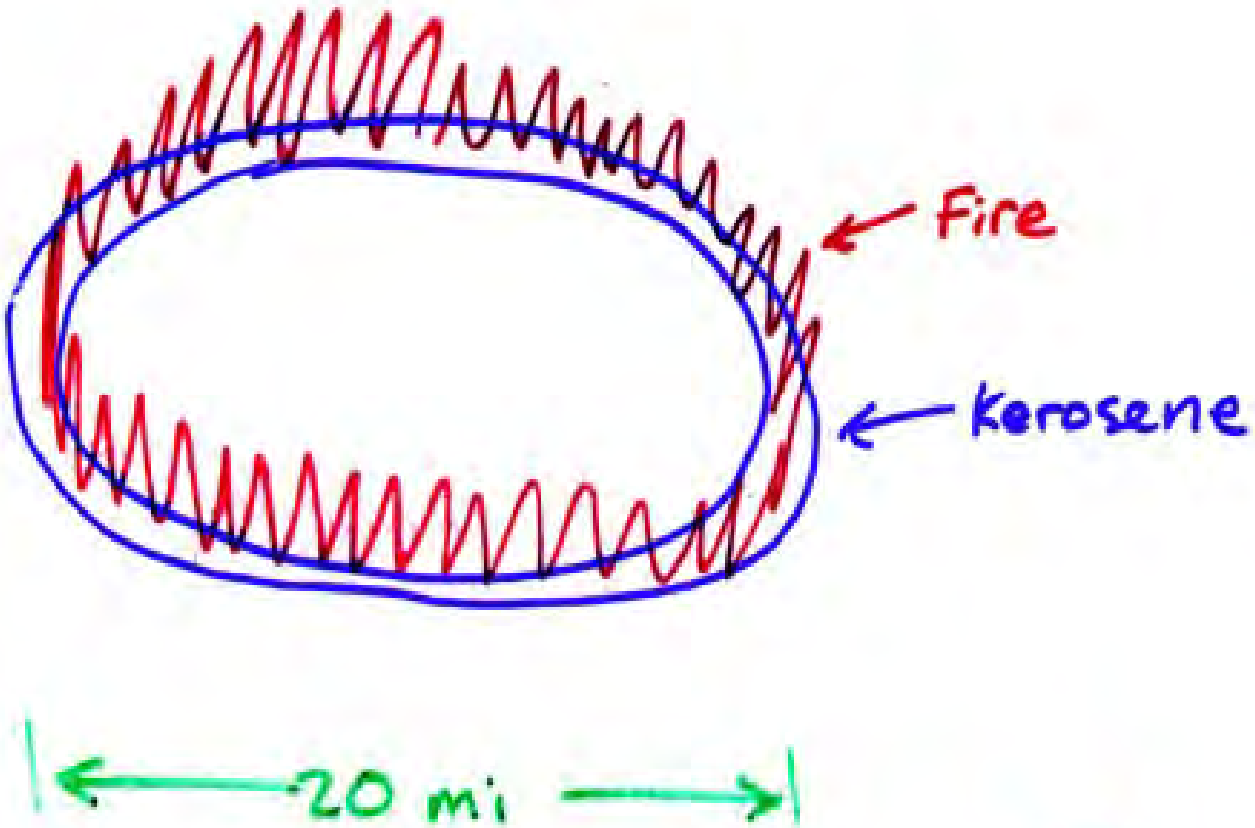
SETI ideas morphing over 200 years

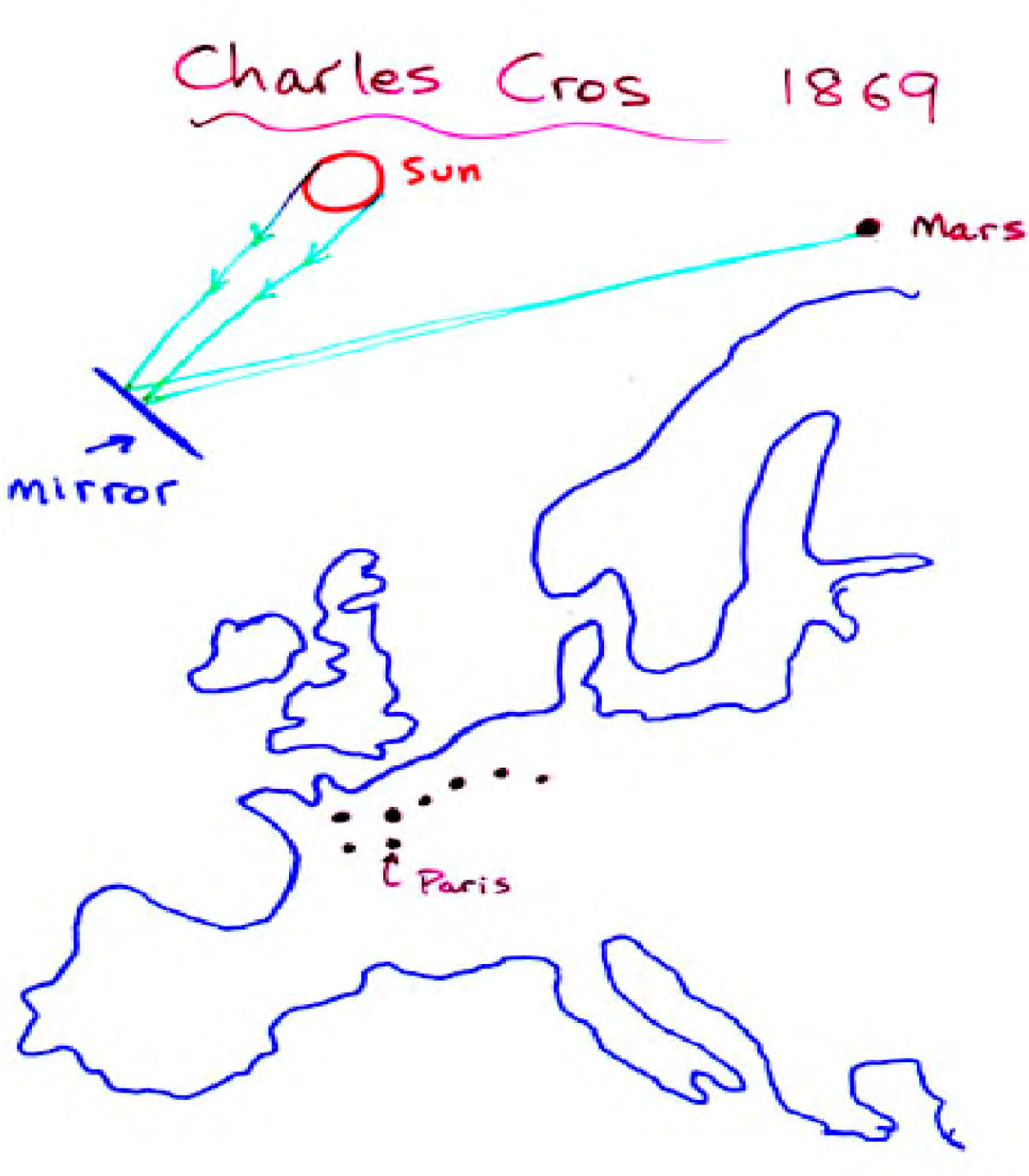
We are likely doing the wrong thing

Karl Gauss 1820



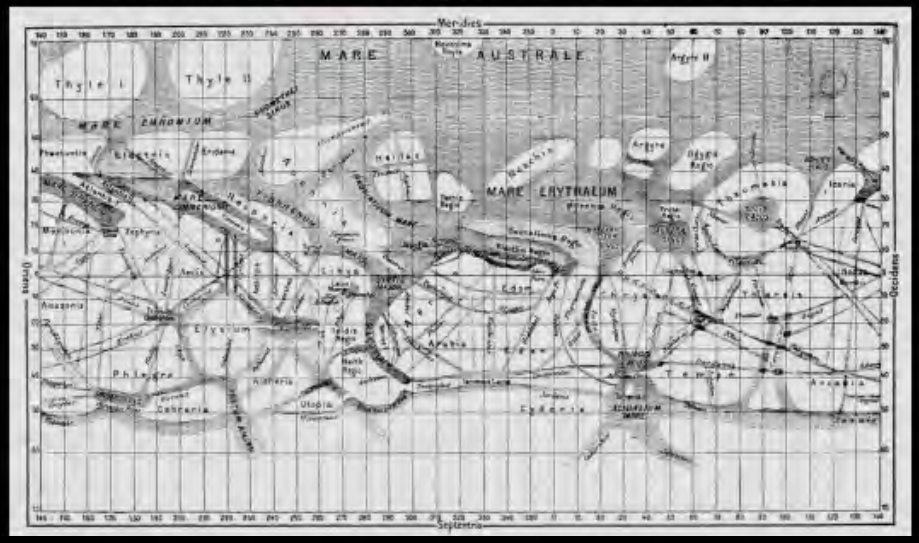
Joseph Von Littron ~1840




Charles Cros 1869
Sun
Mars
mirror
Paris

Giovanni Schiaparelli
1835-1910

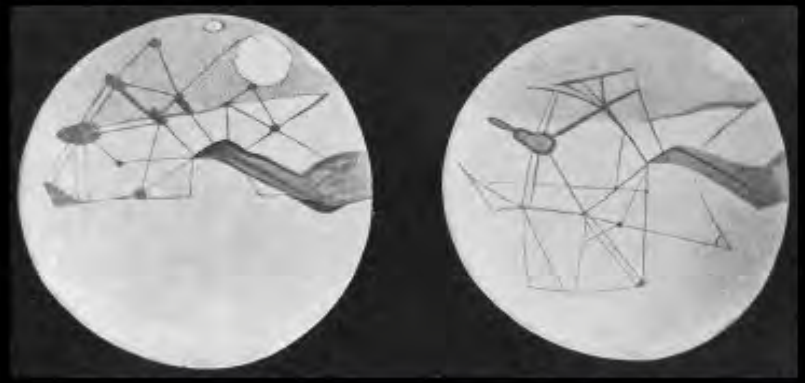
He reported seeing "canali" (grooves in Italian) on its surface in 1871.



Percival Lowell presumes the canali to be canals and builds an observatory to study the planet

Percival Lowell
1855-1916

Many in the last decade of the 19th century onward thought Mars was inhabited and the canals were a last ditch attempt to bring water from the polar caps to the temperate areas to service a dying civilization.



Two of Lowell's drawings of Mars and of its canals

Last Century – Mostly Radio SETI

- Nikola Tesla (1899)
  - Announces "coherent signals from Mars"
- Guglielmo Marconi (1920) strange signals
- Navy observes Mars on closest approach
- Frank Drake (1960)
  - Project Ozma
  - one channel, 1420-1420.4 MHz

OPTICAL SETI -
Example of anthropomorphic SETI

1961 Charlie Townes Paper

largely ingored until 1999

1971 Cyclops report calculates radio >> optical

Today's lasers can communicate across galaxy

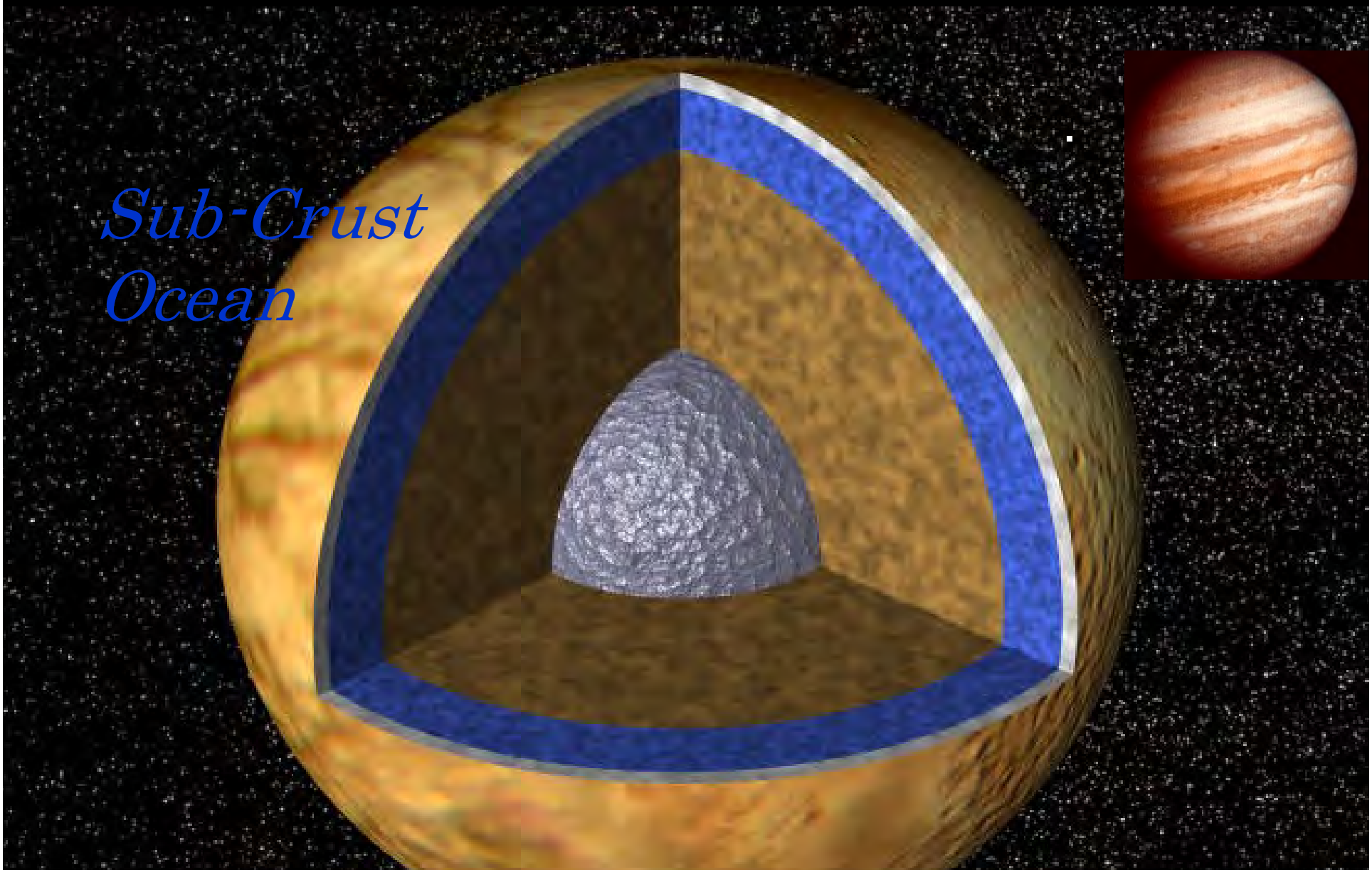
Habitable planets and stars – Example of anthropomorphic SETI

Habitable Zone → other ways to heat

F and G stars only → many stellar types

no binary stars -→ stable planetary orbits

Europa – Liquid water outside habitable zone



Anthropocentric SETI ?

It's naïve to think we know how best to search today.

We are an emerging civilization,

with rapidly changing science

and ideas for interstellar communication.

Earth's History in One Year

-4	ms	Gauss, von Litron, Cros SETI ideas
-2	ms	Radio Communication
-1	ms	Ozma SETI at Green Bank
0.2	ms	GBT SETI

It's naïve to think we know how best to search today, given our history of changing SETI fashion.

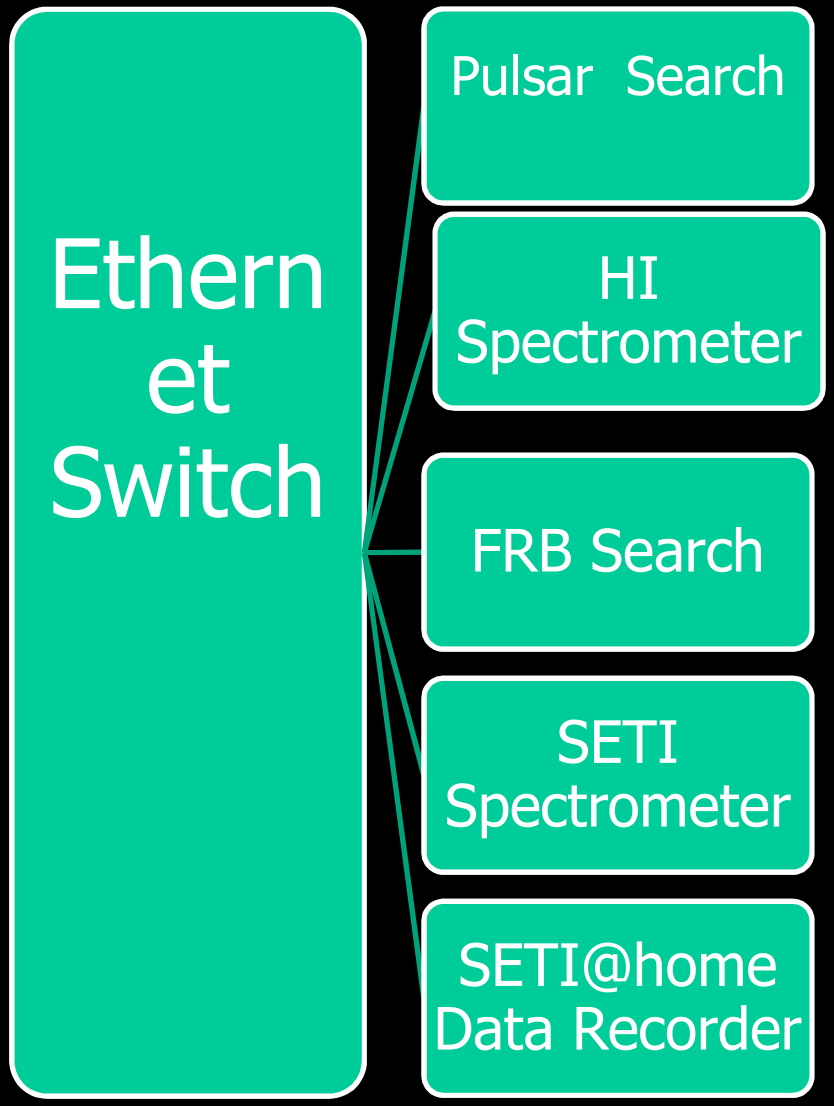
- Multiple strategy is best

  IR, Vis, Radio, pulse, continuous, targeted, sky survey…

- Half of astronomy discoveries are serendipitous
- Examine glitches in data – anomaly detection
- Data Mining Experiments

Future SETI Experiments

FAST Multibeam 3 yr. Sky Survey
Four Simultaneous Surveys



PANORAMIC-SETI:

Pulsed All-sky Near-infrared Optical SETI

PANOSETI (with 1000 FPGAs)

Shelley Wright, Paul Horowitz, Jerome Maire

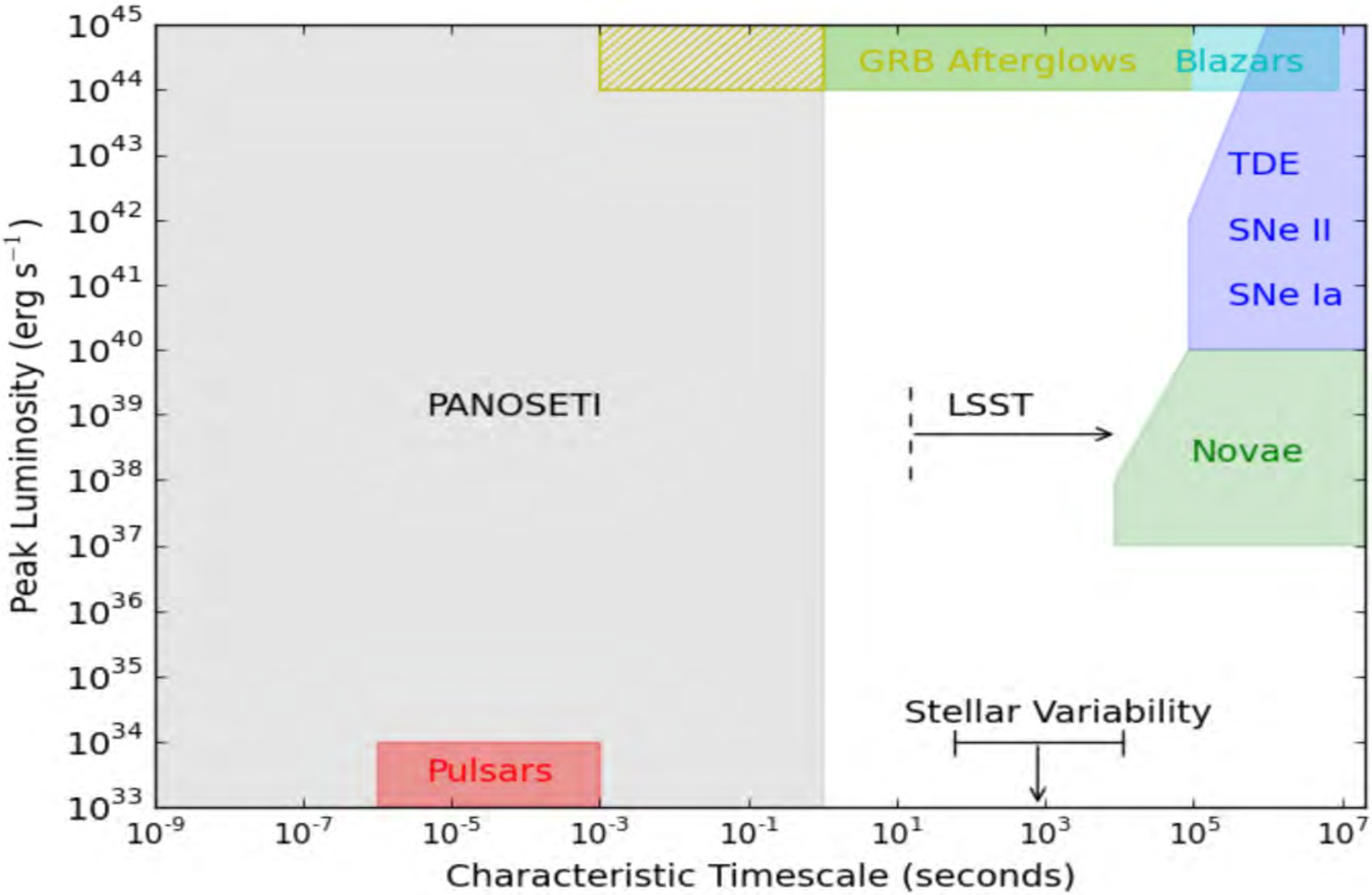
Franklin Antonio, Aaron Brown, Maren Cosens

Frank Drake, Andrew Howard, Wei Liu, Ryan Lee

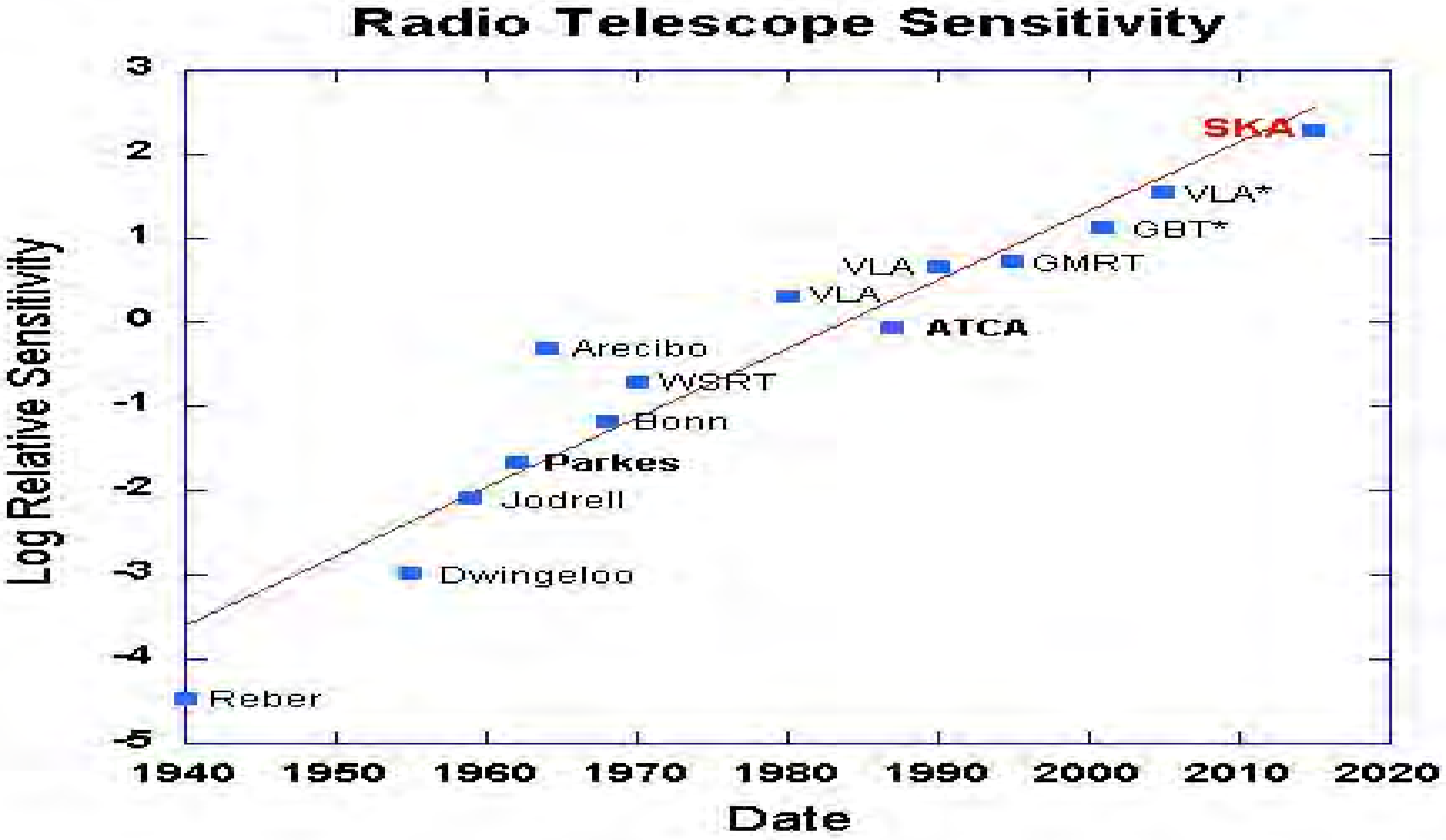
Rick Raffanti, Rem Stone, Dan Werthimer

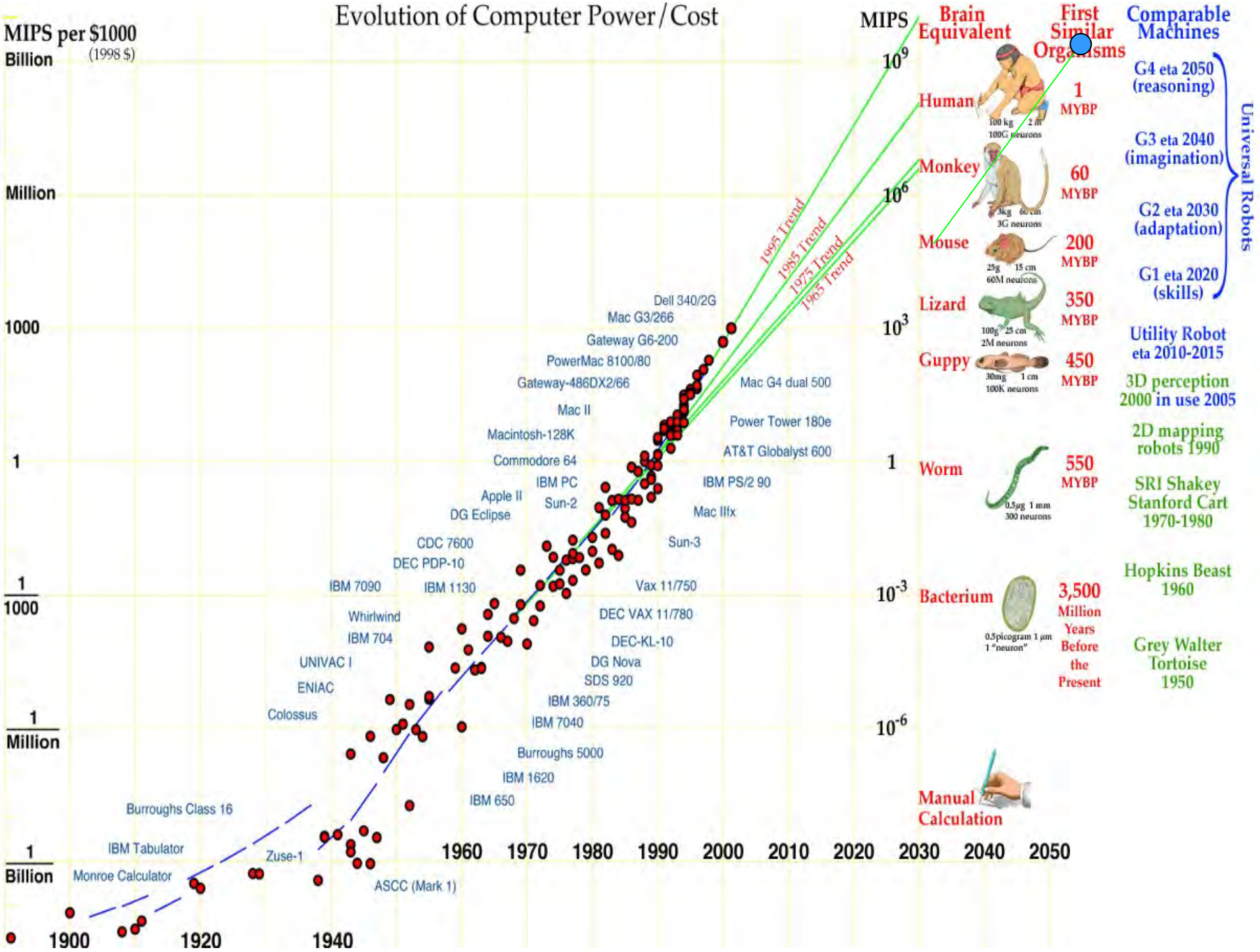
PANOSETI:
Telescopes operating at Lick during COVID19 Crisis (Pajama Mode)

PANOSETI: exploring new time domains over large sky coverage with a long cadence

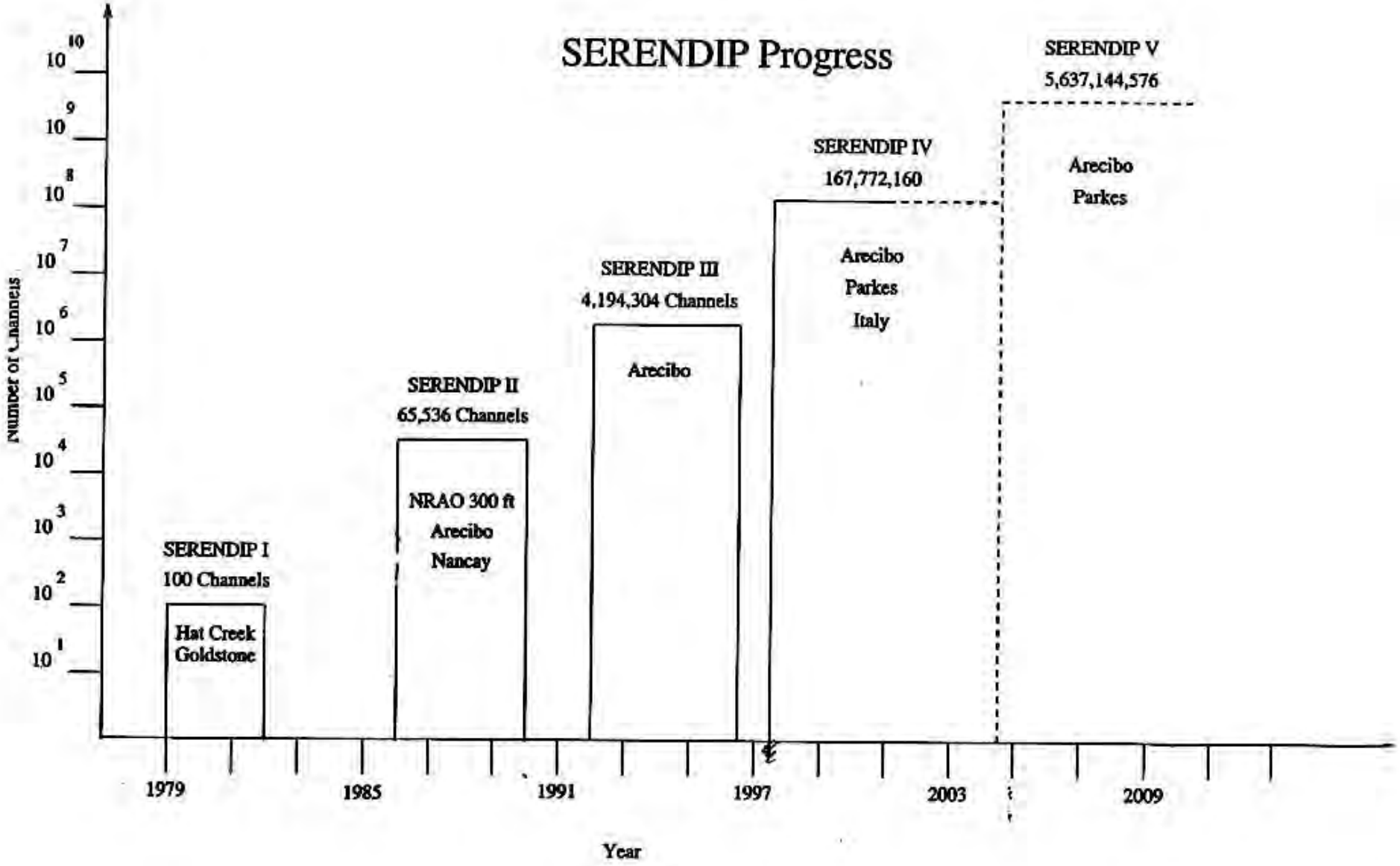


Radio Telescope Sensitivity doubles every 3.6 years




Evolution of Computer Power/Cost
MIPS per $1000
(1998 $)
Billion
Million
1000
1
1/1000
1/Million
1/Billion
1900
1920
1940
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
Dell 340/2G
Mac G3/266
Gateway G6-200
PowerMac 8100/80
Gateway-486DX2/66
Mac II
Macintosh-128K
Commodore 64
IBM PC
Apple II
Sun-2
DG Eclipse
CDC 7600
DEC PDP-10
IBM 7090
IBM 1130
Whirlwind
IBM 704
UNIVAC I
ENIAC
Colossus
Burroughs Class 16
IBM Tabulator
Monroe Calculator
Zuse-1
ASCC (Mark 1)
IBM 650
IBM 1620
Burroughs 5000
IBM 7040
IBM 360/75
DG Nova
SDS 920
DEC-KL-10
DEC VAX 11/780
Vax 11/750
Sun-3
Mac IIfx
IBM PS/2 90
AT&T Globalyst 600
Power Tower 180e
Mac G4 dual 500
1995 Trend
1985 Trend
1975 Trend
1965 Trend
MIPS
10^9
10^6
10^3
1
10^{-3}
10^{-6}
Brain Equivalent
First Similar Organisms
Comparable Machines
Human
100 kg 2 m
100G neurons
1 MYBP
Monkey
3kg 60 cm
3G neurons
60 MYBP
Mouse
25g 15 cm
60M neurons
200 MYBP
Lizard
100g 25 cm
2M neurons
350 MYBP
Guppy
30mg 1 cm
100K neurons
450 MYBP
Worm
0.5µg 1 mm
300 neurons
550 MYBP
Bacterium
0.5picogram 1 µm
1 "neuron"
3,500 Million Years Before the Present
Manual Calculation
G4 eta 2050 (reasoning)
G3 eta 2040 (imagination)
G2 eta 2030 (adaptation)
G1 eta 2020 (skills)
Universal Robots
Utility Robot eta 2010-2015
3D perception 2000 in use 2005
2D mapping robots 1990
SRI Shakey Stanford Cart 1970-1980
Hopkins Beast 1960
Grey Walter Tortoise 1950

Number of SETI Channels doubles every 20 months
100 channels to 100 billion channels in 40 years



Use Sun As Gravitational Lens

Place camera at focus 1E11 km

10 meter resolution on Extrasolar Planet

SETI is

Archeology of the Future

Profound Either Way

Summary and Conclusion

No ET so far

Still working on it

SETI HAIKU

Searching for life
Answers are revealed
About ourselves

Paula Cook, Duke University

One million earthlings
Bounded by optimism
Leave their PC's on

Dan Seidner

SETI SPIN OFFS

BOINC Public Participation Scientific Supercomputing

Volunteer Computing

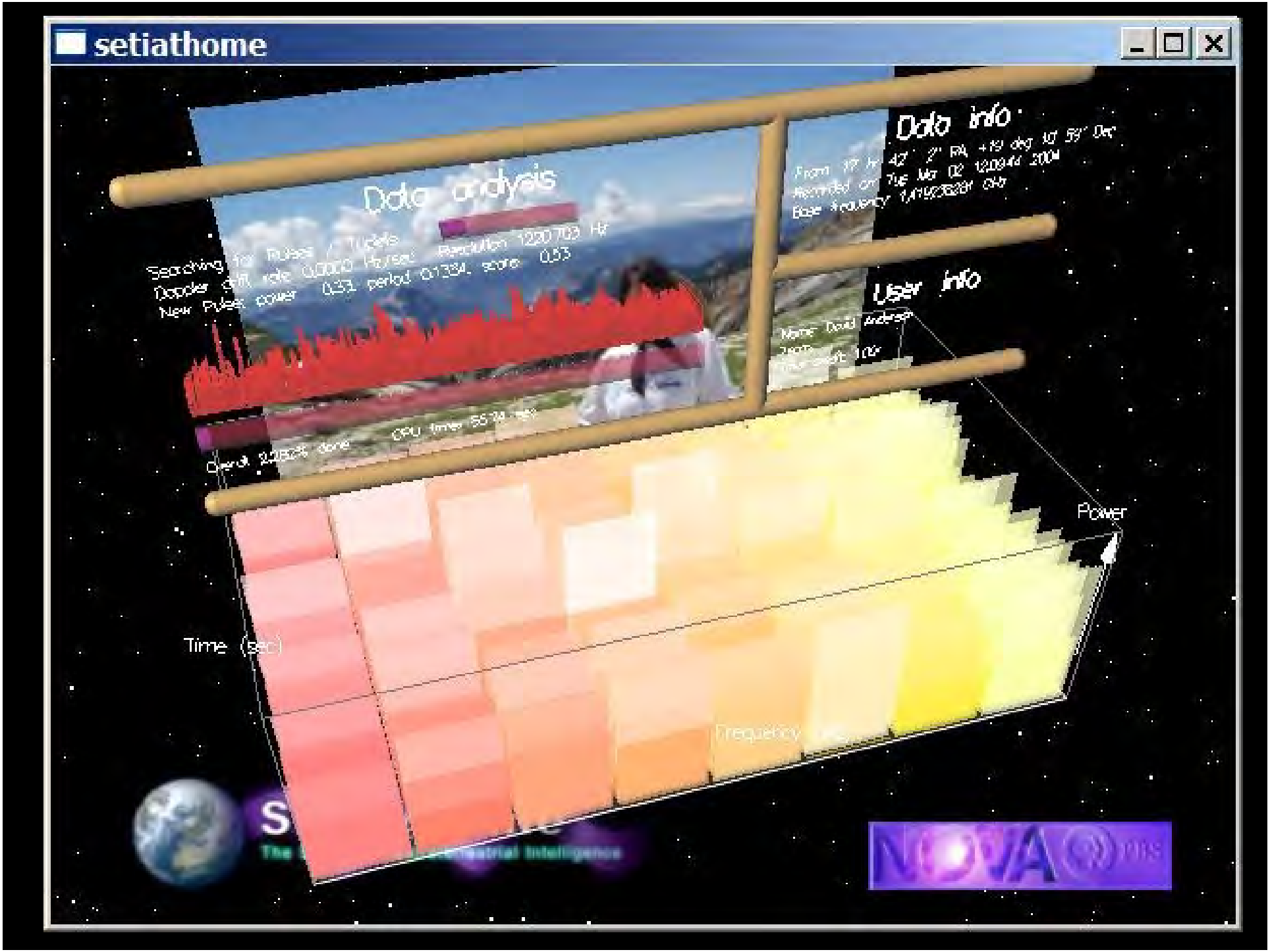
Distributed Computing

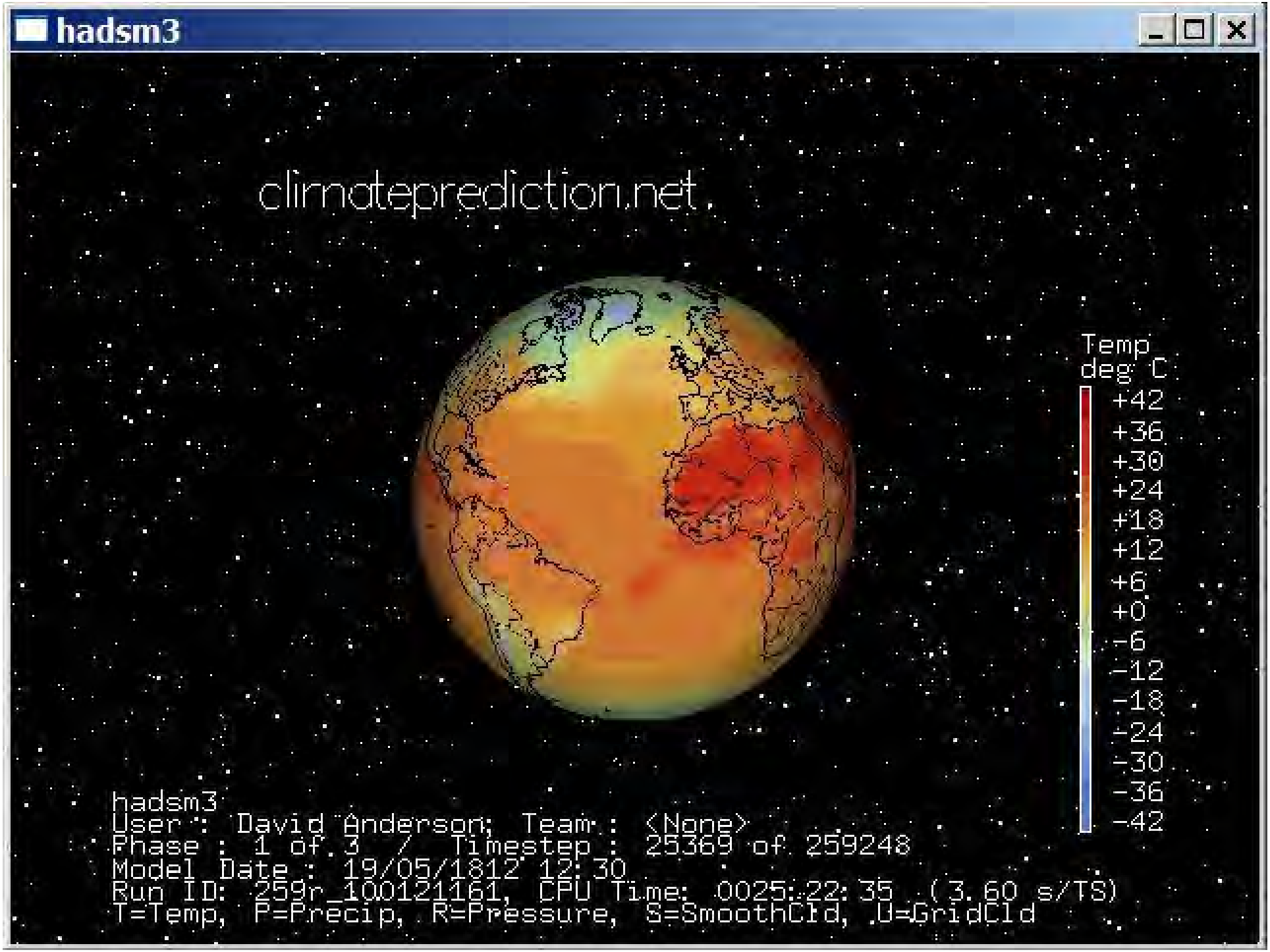
Edge Resource Aggregation

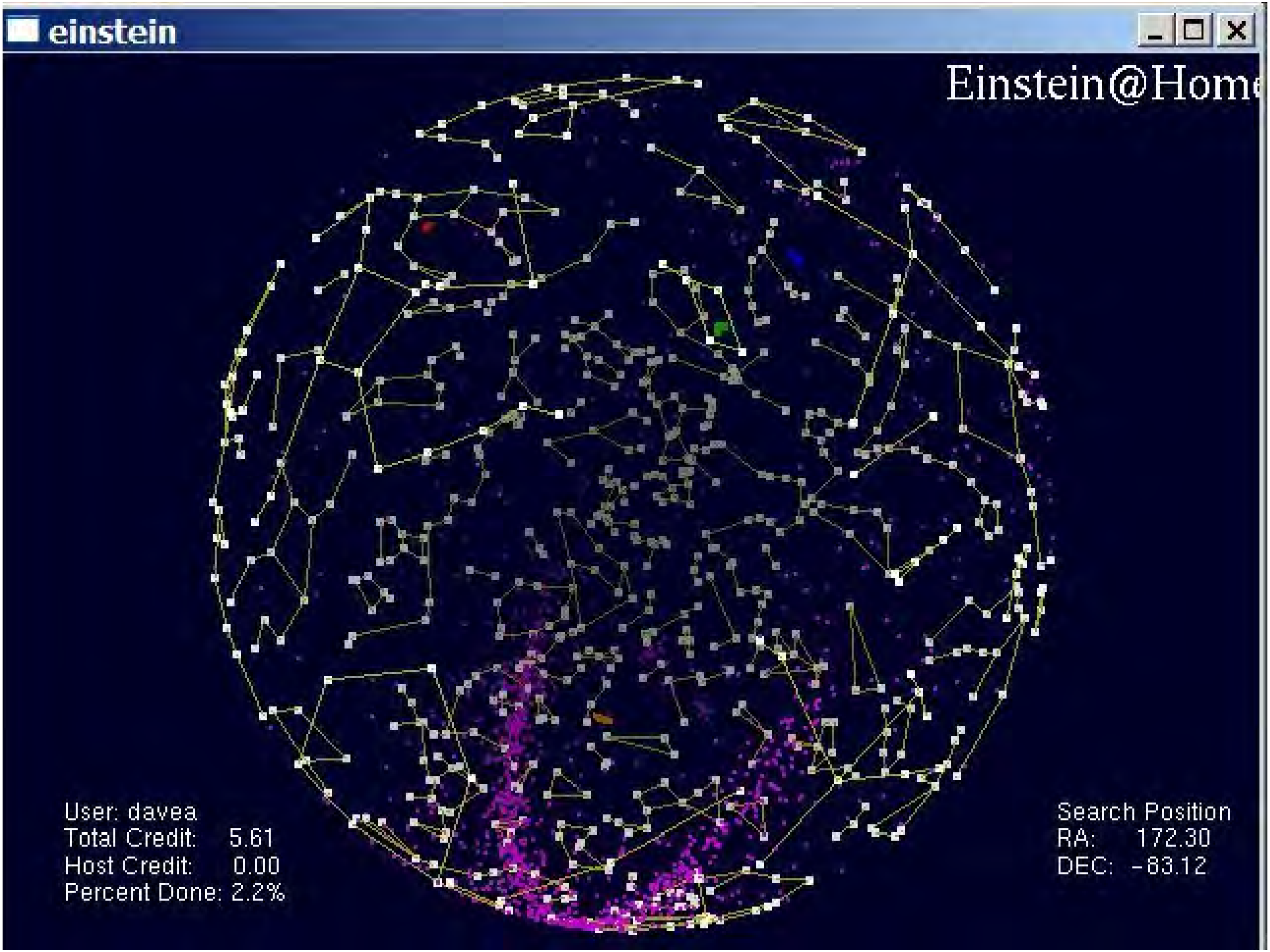
"Democritization of Scientific Supercomputing"

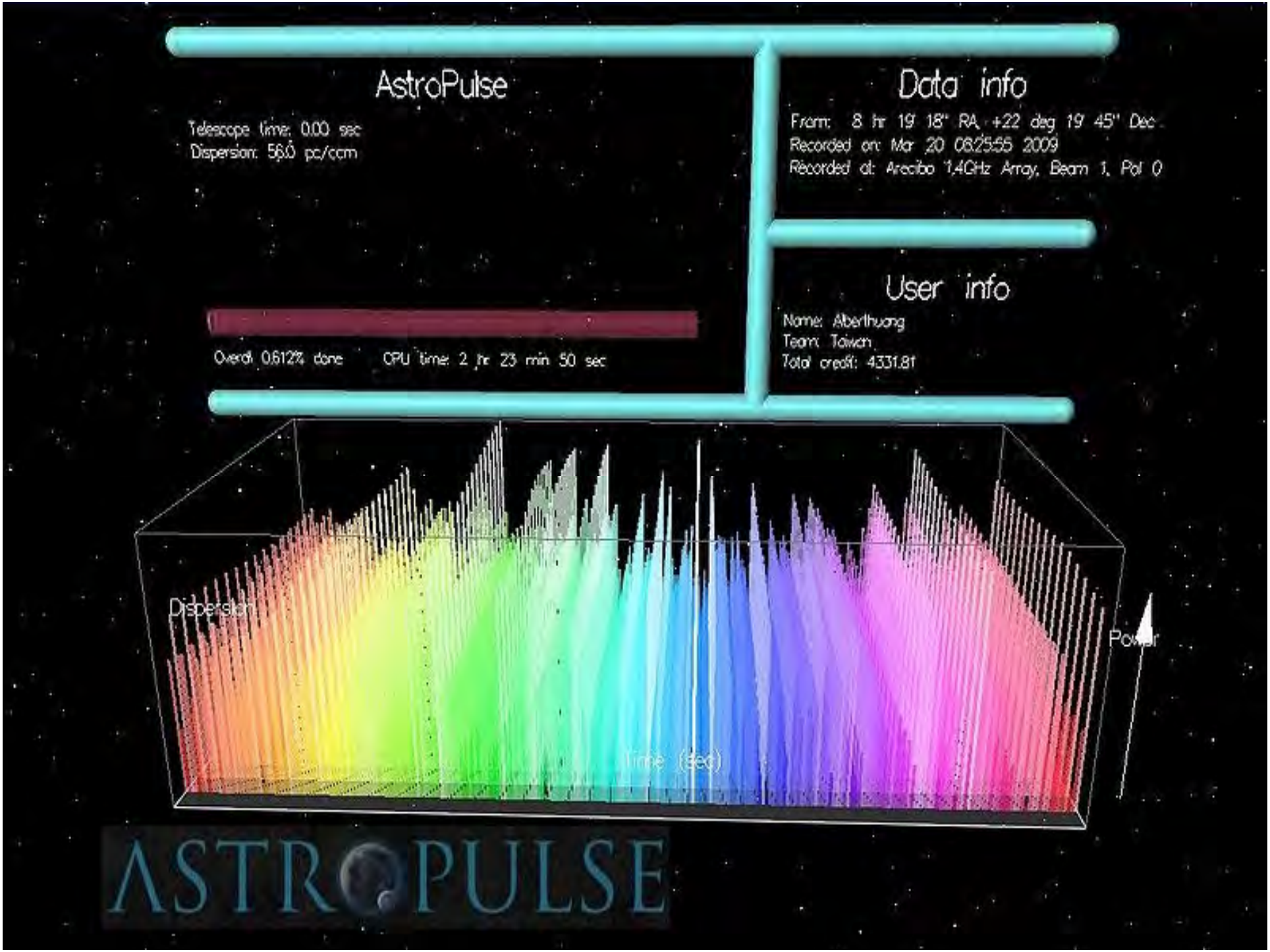
BOINC Volunteer ComputingProjects

- Astronomy
  - SETI@home (Berkeley)
  - Astropulse (Berkeley)
  - Einstein@home: gravitational pulsar search (Albert Einsten Institute/Max Planck)
  - PlanetQuest (SETI Institute)
  - Stardust@home (Berkeley, Univ. Washinton,…)
- Earth science
  - Climateprediction.net (Oxford)
- Biology/Medicine
  - Folding@home, Predictor@home (Stanford, Scripts)
  - FightAIDSathome: virtual drug discovery
- Physics
  - LHC@home (Cern)
- Other
  - Web indexing/search
  - Internet Resource mapping (UC Berkeley)

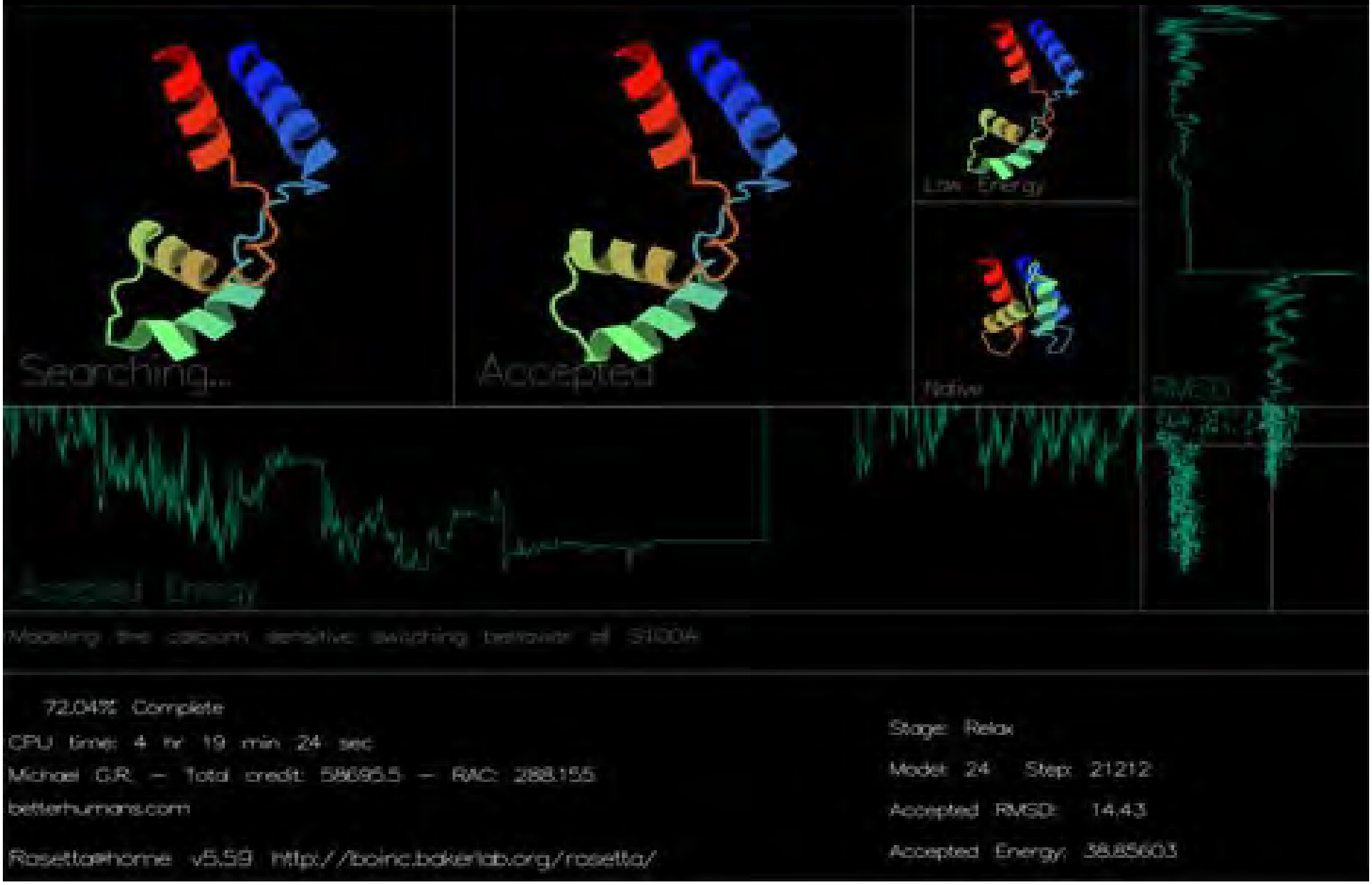

setiathome
Data analysis
Searching for Pulses
Resolution 1220703 Hz
Data info
User info
Power
Time (sec)
Frequency


hadsm3
climateprediction.net
Temp
deg C
+42
+36
+30
+24
+18
+12
+6
+0
-6
-12
-18
-24
-30
-36
-42
hadsm3
User : David Anderson; Team : <None>
Phase : 1 of 3 / Timestep : 25369 of 259248
Model Date : 19/05/1812 12:30
Run ID: 259r_100121161, CPU Time: 0025:22:35 (3.60 s/TS)
T=Temp, P=Precip, R=Pressure, S=SmoothCld, G=GridCld

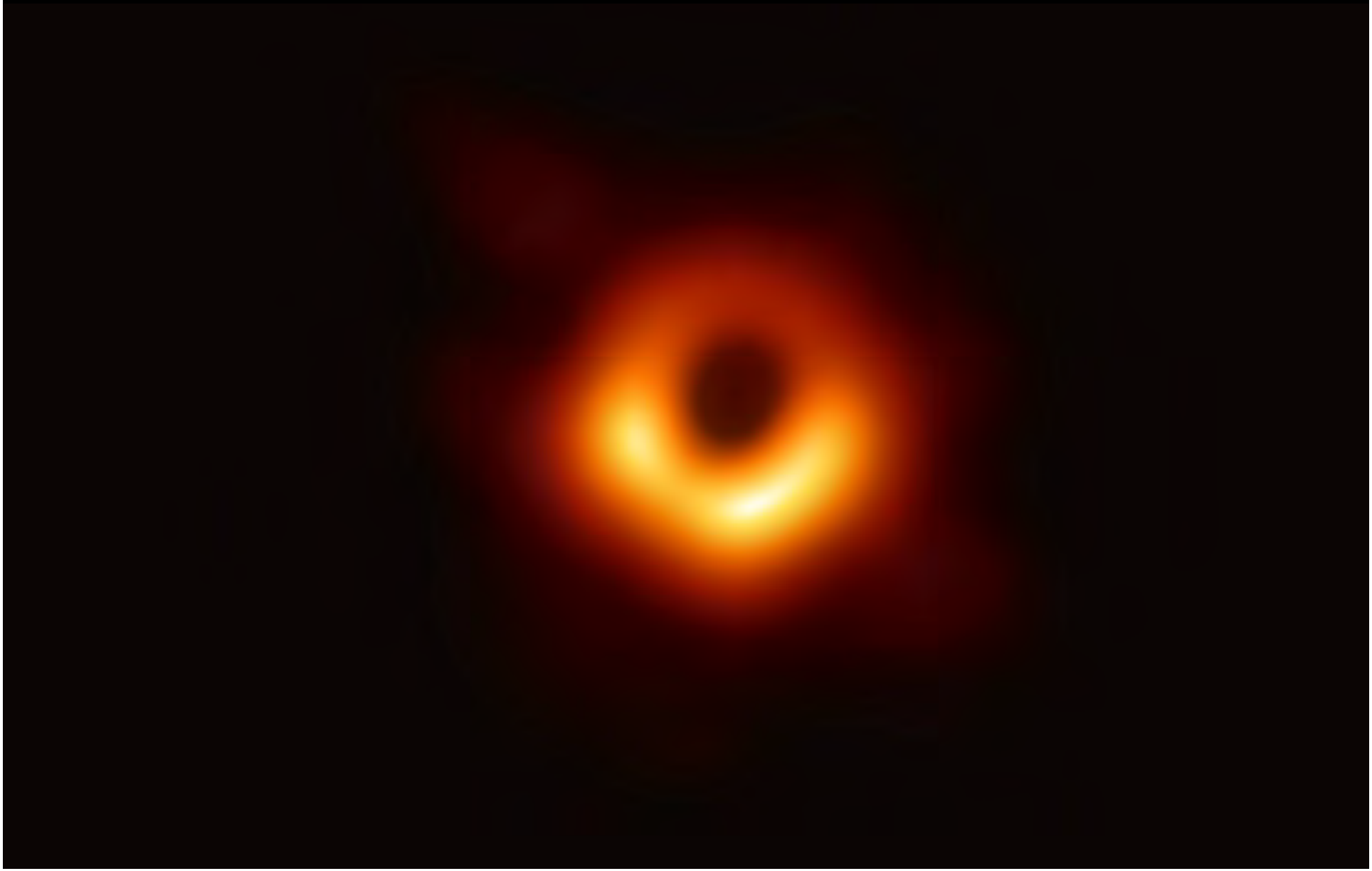

einstein
Einstein@Home
User: davea
Total Credit: 5.61
Host Credit: 0.00
Percent Done: 2.2%
Search Position
RA: 172.30
DEC: -83.12


AstroPulse
Telescope time: 0.00 sec
Dispersion: 56.0 pc/ccm
Overall 0.612% done
CPU time: 2 hr 23 min 50 sec
Data info
From: 8 hr 19' 18" RA +22 deg 19' 45" Dec
Recorded on: Mar 20 08:25:55 2009
Recorded at: Arecibo 1.4GHz Array, Beam 1, Pol 0
User info
Name: Alberthuang
Team: Taiwan
Total credit: 4331.81
Dispersion
Time (sec)
Power
ASTROPULSE

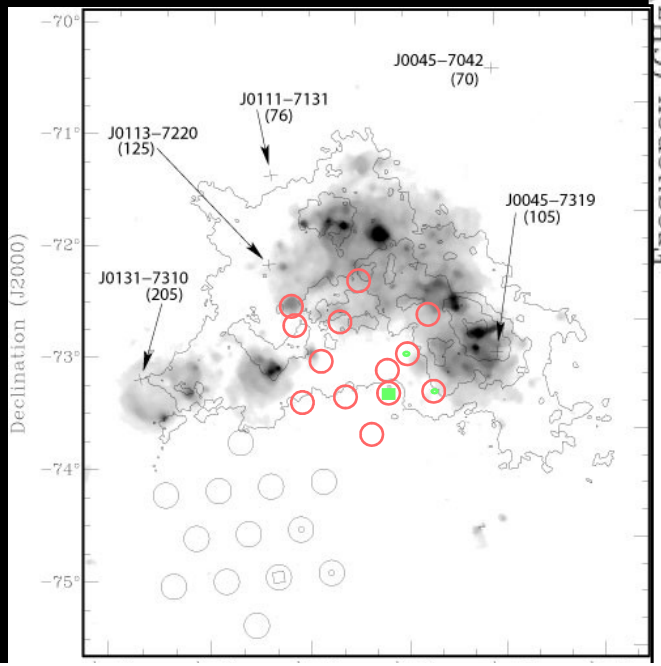
Rosetta Screensaver

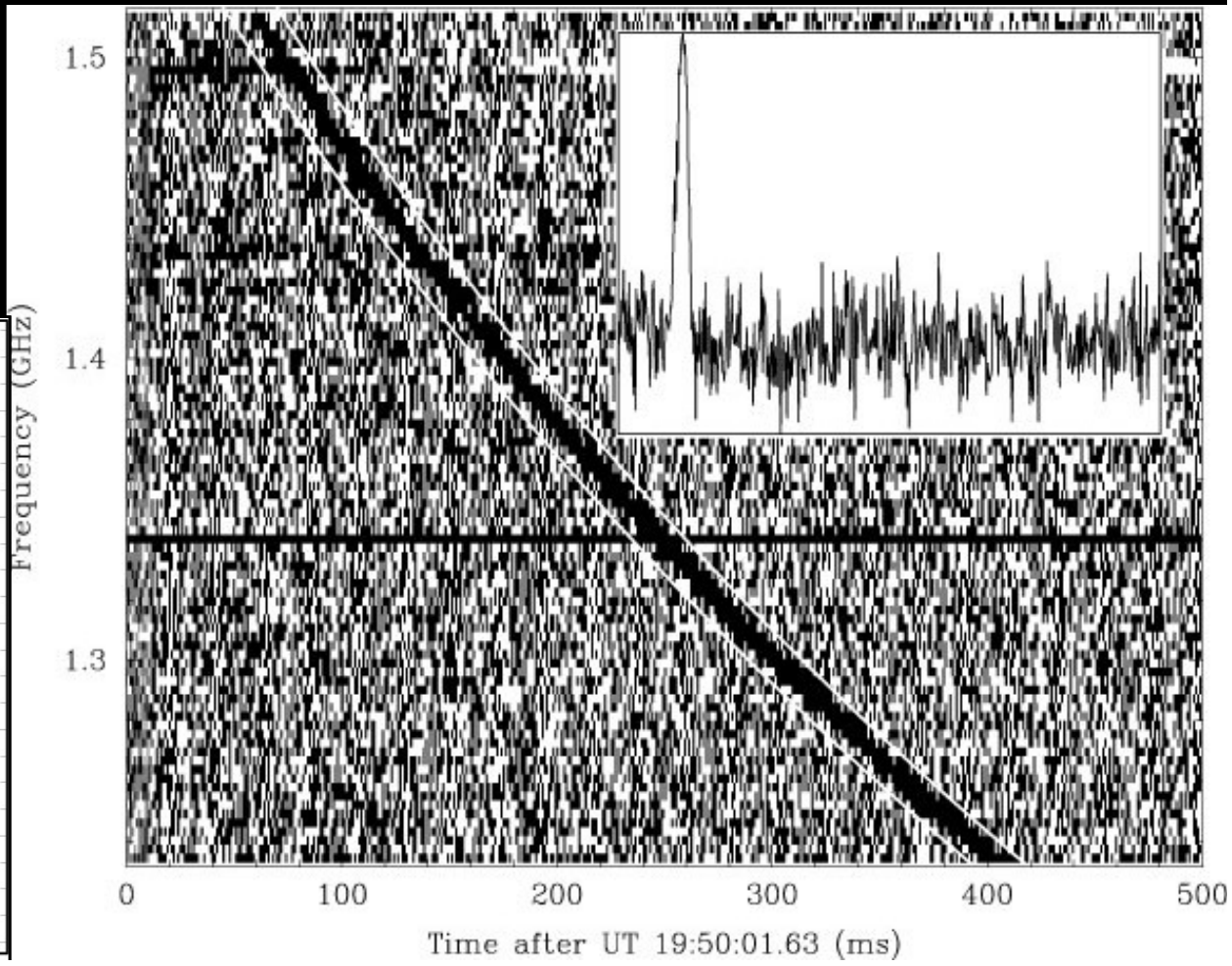


First Image of Black Hole used SETI derived instrument



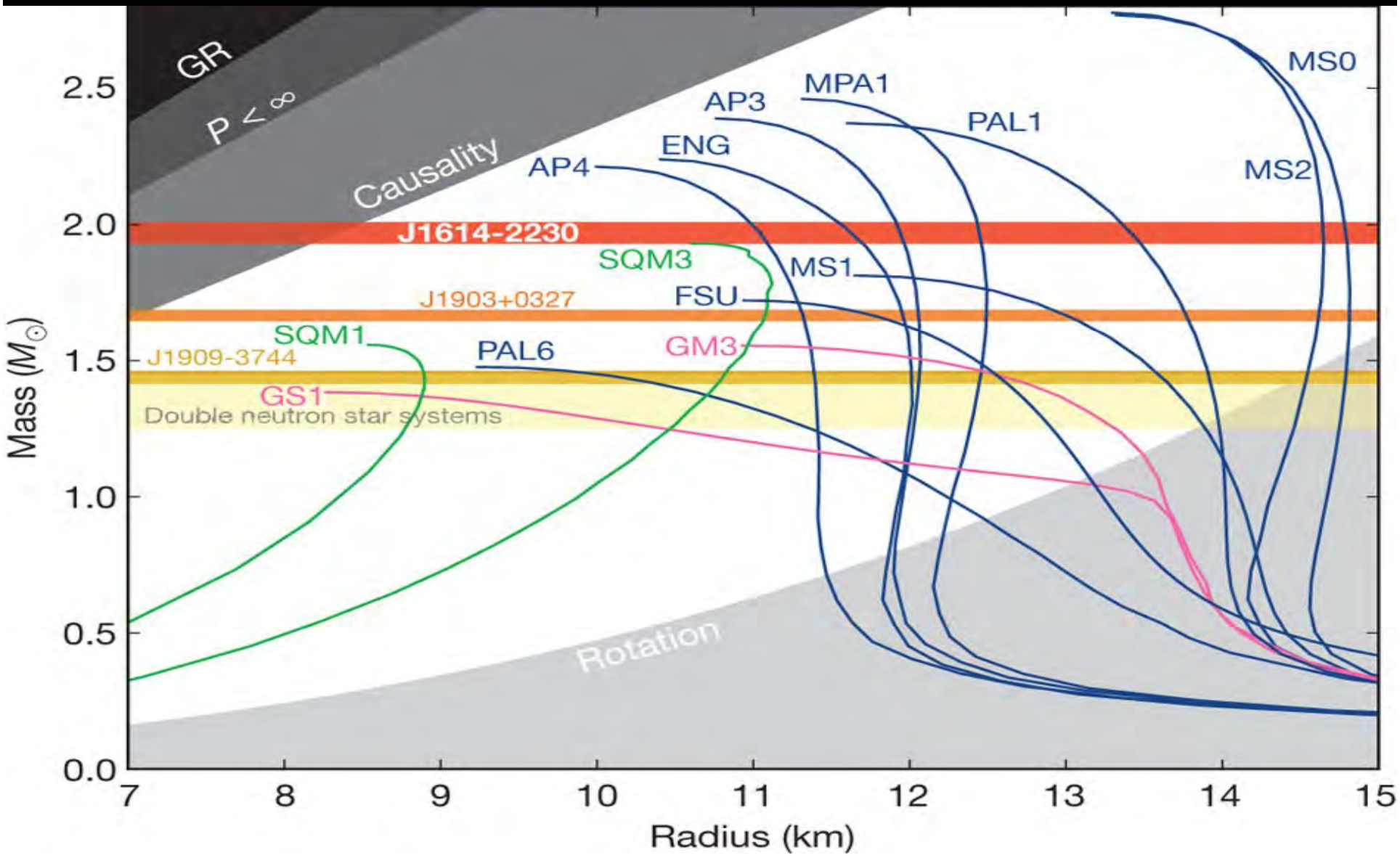
Most Fast Radio Bursts from SETI based instrumentation





Most Pulsars are from CASPER/SETI

Instrumentation at Arecibo (Mock), Green Bank, Parkes…



Diamond Planet: Matthew Bailes et al